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EXAMINER	
PHAM, THANHHA S	
ART UNIT	**PAPER NUMBER**
2813	

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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/657,416	TSUJI ET AL.	
	Examiner	Art Unit	
	Thanhha Pham	2813	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *29 August 2005*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-12* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☒ Claim(s) *2 and 10* is/are allowed.

6)☐ Claim(s) *1,3-9,11 and 12* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *6/20/2005*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

This Office Action is in response to Applicant's Amendment dated 08/29/2005.

Election/Restrictions

1. Claim 2 generic and allowable. Accordingly, the restriction requirement as to the encompassed species is hereby withdrawn and claim 10, directed to the species of II no longer withdrawn from consideration since all of the claims to this species depend from or otherwise include each of the limitations of an allowed generic claim.

In view of the above noted withdrawal of the restriction requirement as to the linked species, applicant(s) are advised that if any claim(s) depending from or including all the limitations of the allowable generic linking claim(s) be presented in a continuation or divisional application, such claims may be subject to provisional statutory and/or nonstatutory double patenting rejections over the claims of the instant application. Once a restriction requirement is withdrawn, the provisions of 35 U.S.C. 121 are no longer applicable. See *In re Ziegler*, 44 F.2d 1211, 1215, 170 USPQ 129, 131-32 (CCPA 1971). See also MPEP § 804.01.

Claim Rejections - 35 USC § 112

The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

2. Claim 4-5, 7, 8 and 12 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

► With respect to claim 4, "the oxidizing gas in the second source gas has a flow rate which is more than 1.0 times that of the silicon-containing hydrocarbon gas" renders the claim indefinite. It is not clear that the term "that of the silicon-containing hydrocarbon gas" is a flow rate of which silicon-containing hydrocarbon gas – the silicon-containing hydrocarbon gas in the first or the second source gas?

► With respect to claim 7, it is not clear that "the silicon-containing hydrocarbon" as cited in claim 7 is the silicon-containing hydrocarbon comprised in the first source gas or in the second source gas.

► With respect to claim 8, it is not clear that "the oxidizing gas" refers to which oxidizing gas of which source gas – the first source gas or the second source gas (see claim 3 for details)

► With respect to claim 12, it is not clear that if "subjecting the insulating film to polishing for forming a subsequent layer thereon" (line 8) is the same or different to "the polishing conducting thereafter is chemical mechanical polishing (CMP)" (lines 10-11)

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the

invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

3. Claims 1, 3-6, and 12, as being best understood, are rejected under 35 U.S.C. 103(a) as being unpatentable over Kim [US 2002/0106891] in view of Huang et al [US 2003/0235980].

► With respect to claims 1 and 6, Kim et al (figs 2-9, text pages 1-6) discloses a method for forming an interlayer insulation film for multilayer interconnect of a semiconductor integrated circuit, comprising the steps of:

forming a first insulation film (110, fig 5, text [0047], [0035]-[0036]) on a substrate in a reactor by plasma CVD using a first source gas comprising a silicon-containing hydrocarbon gas (e.g. trimethylsilane);

continuously forming a second insulation film (130, fig 7, text [0050)]on the first insulation film in the same reactor at a thickness less than the first insulation film in situ by plasma CVD using a second source gas comprising a silicon-containing hydrocarbon gas wherein the silicon-containing hydrocarbon in the second source gas has the formula $Si_{\alpha}O_{\alpha-1}R_{2\alpha-\beta+2}(OC_nH2_{n+1})_{\beta}$ where α is an integer of 1-3, β is an integer of 0-2, n is an integer of 1-3, and R is C_{1-6} hydrocarbon attached to Si; and

subjecting the second insulation film to polishing (text [0052])

Kim et al is silent about:

a) said second source gas comprising an oxidizing gas

b) said polishing for forming a subsequent layer thereon

Regarding to **a)**, using the second source gas comprising the silicon-containing hydrocarbon and the oxidizing gas to form the insulating film has been known in the art.

In addition, Huang et al (fig 1-3 and text pages 1-5) teaches using the second source gas comprising the silicon-containing hydrocarbon (TEOS) and the oxidizing gas (O_2) to forming the second insulating film (22, fig 1-3, text [0039]-[0049] and [0069]-[0075]) as an improved hard mask with good characteristics of moisture blocking and reduced dielectric constant. Therefore, at the time of invention, it would have been obvious for those skilled in the art, in view of Huang et al, to use the second source gas as in **a)** in the process Kim et al to provide a good device with improved characteristic of the second insulating film with reason given above.

Regarding to **b)**, the intended use of the second insulating film does not result in a structure difference between the claim invention and the prior art in order to patentably distinguish the claimed invention from the prior art since applicant does not positively cite a step of forming a subsequent layer. If the prior structure is capable of performing the intended use, then it meets the claim. *Ex parte Masham, 2 USPQ2d 1647 (1987)*. Moreover, forming a subsequent layer on an insulating film after being polished has been very well-known in the art. It would been obvious for those skilled in the art to form the subsequent layer on the second insulating film after polishing the second insulating film in the process of Kim et al in view of Huang et al to build up multilevel interconnect in a semiconductor device.

► With respect to claims 3-5, the claimed range parameters of flow rate and RF power are considered involve routine optimization while has been held to be within the level of ordinary skill in the art. As noted in In re Aller 105 USPQ233, 255 (CCPA

1955), the selection of reaction parameters such as temperature and concentration would have been obvious.

> "Normally, it is to be expected that a change in temperature, or in concentration, or in both, would be an unpatentable modification. Under some circumstances, however, changes such as these may be impart patentability to a process if the particular ranges claimed produce a new and unexpected result which is different in kind and not merely degree from the results of the prior art...such ranges are termed "critical ranges and the applicant has the burden of proving such criticality... More particularly, where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation."
>
> *See also In re Waite 77 USPQ 586 (CCPA 1948); In re Scherl 70 USPQ 204 (CCPA 1946); In re Irmscher 66 USPQ 314 (CCPA 1945); In re Norman 66 USPQ 308 (CCPA 1945); In re Swenson 56 USPQ 372 (CCPA 1942); In re Sola 25 USPQ 433 (CCPA 1935); In re Dreyfus 24 USPQ 52 (CCPA 1934).*

► With respect to claim 12, as being best understood, Kim et al (figs 2-9, text pages 1-6) discloses a method for forming an interlayer insulation film for multilayer interconnect of a semiconductor integrated circuit, comprising the steps of:

> forming a first insulation film (110, fig 5, text [0047], [0035]-[0036]) on a substrate in a reactor by plasma CVD using a first source gas comprising a silicon-containing hydrocarbon gas (e.g. trimethylsilane);

continuously forming a second insulation film (130, fig 7, text [0050)]on the first insulation film in the same reactor at a thickness less than the first insulation film in situ by plasma CVD using a second source gas comprising a silicon-containing hydrocarbon gas wherein the silicon-containing hydrocarbon in the second source gas has the formula $Si_\alpha O_{\alpha-1} R_{2\alpha-\beta+2}(OC_nH2_{n+1})_\beta$ where α is an integer of 1-3, β is an integer of 0-2, n is an integer of 1-3, and R is C_{1-6} hydrocarbon attached to Si;

forming via holes (140) and trenches (150) in the first and second insulating film, and filling the holes and trenches with metal for interconnect (170/180) .and

subjecting the second insulation film to polishing.

Kim et al is silent about:

a) said second source gas comprising an oxidizing gas

b) said polishing for forming a subsequent layer thereon

c) said metal for interconnect (170/180) being of copper

Regarding to **a)**, using the second source gas comprising the silicon-containing hydrocarbon and the oxidizing gas to form the insulating film has been known in the art. In addition, Huang et al (fig 1-3 and text pages 1-5) teaches using the second source gas comprising the silicon-containing hydrocarbon (TEOS) and the oxidizing gas (O_2) to forming the second insulating film (22, fig 1-3, text [0039]-[0049] and [0069]-[0075]) as an improved hard mask with good characteristics of moisture blocking and reduced dielectric constant. Therefore, at the time of invention, it would have been obvious for those skilled in the art, in view of Huang et al, to use the second source gas as in **a)** in

the process Kim et al to provide a good device with improved characteristic of the second insulating film with reason given above.

Regarding to **b)**, the intended use of the second insulating film does not result in a structure difference between the claim invention and the prior art in order to patentably distinguish the claimed invention from the prior art since applicant does not positively cite a step of forming a subsequent layer. If the prior structure is capable of performing the intended use, then it meets the claim. *Ex parte Masham, 2 USPQ2d 1647 (1987)*. Moreover, forming a subsequent layer on an insulating film after being polished has been very well-known in the art. It would been obvious for those skilled in the art to form the subsequent layer on the second insulating film after polishing the second insulating film in the process of Kim et al in view of Huang et al to build up multilevel interconnect in a semiconductor device.

Regarding to **c),** Huang et al (text [0067]) shows using copper for interconnect. Therefore, at the time of invention, it would have been obvious for those skilled in the art to modify process of Kim et al by filling the holes and trenches with copper for interconnect to provide a better device good improved electrical conduction since copper is a good metal with good conductivity for interconnection.

4. Claims 1, 4-5 and 11, as being best understood, are rejected under 35 U.S.C. 103(a) as being unpatentable over Li et al [US 6,602,779] in view of Kim et al [US 2002/0106891].

► With respect to claim 1, Li et al (figs 1-5, cols 1-11) discloses a method for forming an interlayer insulation film for multilayer interconnect of a semiconductor integrated circuit, comprising the steps of:

forming a first insulation film (16, fig 1, col 7 lines 54-67 and 12-31]) on a substrate in a reactor by plasma CVD using a first source gas comprising a silicon-containing hydrocarbon gas (e.g. trimethylsilane);

continuously forming a second insulation film (18, fig 1, col 7 lines 11-31) on the first insulation film at a thickness less than the first insulation film by plasma CVD using a second source gas comprising a silicon-containing hydrocarbon gas and an oxidizing gas; and

subjecting the second insulation film to polishing (text [0052])

Li et al is silent about :

a') using the same reactor for forming said first insulating film (16) and said second insulating film (18) in-situ

b') said polishing for forming a subsequent layer thereon

Regarding to **a'),** Kim et al teaches using the same reactor for forming the first and second insulating film in-situ by plasma CVD to reduce production cost and time. Therefore, at the time of invention, it would have been obvious for those skilled in the art to modify process of Li et al by using the same reactor for in-situ plasma CVD the first and second insulating film as being claimed, per taught by Kim et al, to product device conveniently with saving cost and time.

Regarding to **b')**, the intended use of the second insulating film does not result in a structure difference between the claim invention and the prior art in order to patentably distinguish the claimed invention from the prior art since applicant does not positively cite a step of forming a subsequent layer. If the prior structure is capable of performing the intended use, then it meets the claim. *Ex parte Masham, 2 USPQ2d 1647 (1987).* Moreover, forming a subsequent layer on an insulating film after being polished has been very well-known in the art. It would been obvious for those skilled in the art to form the subsequent layer on the second insulating film after polishing the second insulating film in the process of Li et al in view of Kim et al to build up multilevel interconnect in a semiconductor device.

► With respect to claim 4-5, in addition with reason given above (with respect to claim 1), the claimed range parameters of flow rate and RF power are considered involve routine optimization while has been held to be within the level of ordinary skill in the art. *See In re Aller 105 USPQ233, 255 (CCPA 1955); In re Waite 77 USPQ 586 (CCPA 1948); In re Scherl 70 USPQ 204 (CCPA 1946); In re Irmscher 66 USPQ 314 (CCPA 1945); In re Norman 66 USPQ 308 (CCPA 1945); In re Swenson 56 USPQ 372 (CCPA 1942); In re Sola 25 USPQ 433 (CCPA 1935); In re Dreyfus 24 USPQ 52 (CCPA 1934).*

► With respect to claim 11, in addition to reason given above (with respect to claim 1), Li et al (col 8 lines 49-65) shows the second insulating film (18) is composed of multiple layers having different oxygen contents (*grade carbon-doped silicon oxide materials*

would composed of multiple layers having different oxygen contents -- different contribution of carbon in multiple layers would provide different oxygen content contribution in the multiple layers).

5. Claims 3 and 6-9, as being best understood, are rejected under 35 U.S.C. 103(a) as being unpatentable over Li et al [US 6,602,779] in view of Kim et al [US 2002/0106891] and Huang et al [US 6,592,247].

► With respect to claims 3, 8 and 9, Li et al (figs 1-5, cols 1-11) discloses a method for forming an interlayer insulation film for multilayer interconnect of a semiconductor integrated circuit, comprising the steps of:

forming a first insulation film (16, fig 1, col 7 lines 54-67 and 12-31) on a substrate in a reactor by plasma CVD using a first source gas comprising a silicon-containing hydrocarbon gas (e.g. trimethylsilane);

continuously forming a second insulation film (18, fig 1, col 7 lines 11-31) on the first insulation film at a thickness less than the first insulation film by plasma CVD using a second source gas comprising a silicon-containing hydrocarbon gas and an oxidizing gas, wherein the oxidizing gas is at least selected from the group consisting of oxygen, dinitrooxide, ozone, hydrogen peroxide, carbon dioxide and polyalchohol, wherein the silicon-containing hydrocarbon gas in the first source gas and the silicon-containing hydrocarbon gas in the second source gas are the same gas; and

subjecting the second insulation film to polishing (text [0052])

Li et al is silent about :

a1') the first source gas comprises an oxidizing gas having a flow rate which is less than 1.0 times of a flow rate of the silicon-containing hydrocarbon gas being used for forming the first insulating film

a') using the same reactor for forming said first insulating film (16) and said second insulating film (18) in-situ

b') said polishing for forming a subsequent layer thereon

Regarding to **a1'),** Huang et al teaches using the first source gas comprising the oxidizing gas with the flow rate less than 1.0 times of the flow rate of the silicon-containing hydrocarbon in the first source gas to provide an improved insulating film with low-k constant and low moisture content. Therefore, at the time of invention, it would have been obvious for those skilled in the art, in view of Huang et al, to use the first source gas as being claimed in the process of Li et al to provide a better device with improve formation of the first insulating film with low dielectric constant and low moisture content.

Regarding to **a'),** Kim et al teaches using the same reactor for forming the first and second insulating film in-situ by plasma CVD to reduce production cost and time. Therefore, at the time of invention, it would have been obvious for those skilled in the art to modify process of Li et al in view of Huang et al by using the same reactor for in-situ plasma CVD the first and second insulating film as being claimed, per taught by Kim et al, to product device conveniently with saving cost and time.

Regarding to **b')**, the intended use of the second insulating film does not result in a structure difference between the claim invention and the prior art in order to

patentably distinguish the claimed invention from the prior art since applicant does not positively cite a step of forming a subsequent layer. If the prior structure is capable of performing the intended use, then it meets the claim. *Ex parte Masham, 2 USPQ2d 1647 (1987)*. Moreover, forming a subsequent layer on an insulating film after being polished has been very well-known in the art. It would been obvious for those skilled in the art to form the subsequent layer on the second insulating film after polishing the second insulating film in the process of Li et al in view of Kim et al and Huang et al to build up multilevel interconnect in a semiconductor device.

► With respect to claims 6 and 7, Li et al (figs 1-5, cols 1-11) discloses a method for forming an interlayer insulation film for multilayer interconnect of a semiconductor integrated circuit, comprising the steps of:

forming a first insulation film (16, fig 1, col 7 lines 54-67 and 12-31) on a substrate in a reactor by plasma CVD using a first source gas comprising a silicon-containing hydrocarbon gas (e.g. trimethylsilane);

continuously forming a second insulation film (18, fig 1, col 7 lines 11-31) on the first insulation film at a thickness less than the first insulation film by plasma CVD using a second source gas comprising a silicon-containing hydrocarbon gas and an oxidizing gas; and

subjecting the second insulation film to polishing (text [0052])

Li et al is silent about :

a') using the same reactor for forming said first insulating film (16) and said second insulating film (18) in-situ

a2') using the silicon-containing hydrocarbon in the second source gas of dimethyldimethoxysilane for forming the second insulating film

b') said polishing for forming a subsequent layer thereon

Regarding to **a'),** Kim et al teaches using the same reactor for forming the first and second insulating film in-situ by plasma CVD to reduce production cost and time. Therefore, at the time of invention, it would have been obvious for those skilled in the art to modify process of Li et al by using the same reactor for in-situ plasma CVD the first and second insulating film as being claimed, per taught by Kim et al, to product device conveniently with saving cost and time.

Regarding to **a2')**, dimethyldimethoxysilane is a known material for forming insulating film in semiconductor device. Selection of a known material based on its suitability for its intended use supported a prima facie obviousness determination in Sinclair & Carroll Co. v. Interchemical Corp., 325 U.S. 327, 65 USPQ 297 (1945) "Reading a list and selecting a known compound to meet known requirements is no more ingenious than selecting the last piece to put in the last opening in a jig-saw puzzle." 325 U.S. at 335, 65 USPQ at 301. See also In re Leshin, 227 F.2d 197, 125 USPQ 416 (CCPA 1960) (selection of a known plastic to make a container of a type made of plastics prior to the invention was held to be obvious). Moreover, Huang et al teaches using the silicon-containing hydrocarbon gas of dimethyldimethoxysilane to form insulating film with low-k constant and low moisture content. Therefore, at the time of invention, it would have been obvious for those skilled in the art, in view of Huang et al, to use the diemethyldimethoxysilane as the known material to form the second

insulating film in the process of Li et al in view of Kim et al to provide a better device with improve formation of insulating film with low dielectric constant and low moisture content.

Regarding to **b')**, the intended use of the second insulating film does not result in a structure difference between the claim invention and the prior art in order to patentably distinguish the claimed invention from the prior art since applicant does not positively cite a step of forming a subsequent layer. If the prior structure is capable of performing the intended use, then it meets the claim. *Ex parte Masham, 2 USPQ2d 1647 (1987).* Moreover, forming a subsequent layer on an insulating film after being polished has been very well-known in the art. It would been obvious for those skilled in the art to form the subsequent layer on the second insulating film after polishing the second insulating film in the process of Li et al in view of Kim et al and Huang et al to build up multilevel interconnect in a semiconductor device.

Allowable Subject Matter

6. Claims 2 and 10 are allowed.

7. The following is a statement of reasons for the indication of allowable subject matter: Recorded Prior Art fails to disclose or suggest combination process steps of a method for forming an interlayer insulating film for multilayer interconnect of a semiconductor integrated circuit comprising forming a first insulating film on a substrate b y plasma CVD using a first source gas comprising a silicon containing hydrocarbon gas; continuously forming a second insulating film on the first insulating film at a

thickness less than a thickness of the first insulating film in-situ by plasma CVD using a second source gas comprising a silicon-containing hydrocarbon gas and an oxidizing gas wherein the first insulating film has a hardness of less than 6 Gpa and the second insulating film has a hardness of no less than 6 Gpa; and subjecting the second insulating film to polishing.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Thanhha Pham whose telephone number is (571) 272-1696. The examiner can normally be reached on Monday and Thursday 9:00AM - 9:30PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead can be reached on (571) 272-1702. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Thanhha Pham